PROBLEMS OF SAMPLING DESERT ARTHROPODS BEFORE AND AFTER A THERMONUCLEAR CRATERING TEST

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Introduction

On July 6, 1962, the U. S. Atomic Energy Commission detonated a large thermonuclear device at the Nevada Test Site (Project Sedan). The device was buried 635 feet underground and had a total yield of 100±15 kilotons. The explosion ejected about 7.5 million yards of alluvium and produced a crater 320 feet deep and 1200 feet in diameter (Fig. 1). The ejected alluvium was radioactive, and gamma intensities of several hundred milliroentgens/hour persisted for months within a mile of ground zero. After a year, gamma intensities at the edge of the crater were still about 15 mr/hour.

Some of the effects of this test on plants and animals in areas near ground zero have already been reported (Allred *et al.* 1964, Jorgensen *et al.* 1963, Martin 1963, and Turner and Gist 1965). One feature of the biological studies was an analysis of selected arthropods near ground zero before and after the test. The study was restricted to species which could be sampled readily with sunken can traps, and which were known to be well represented in the test area. I sought evidence of possible changes in species composition, or in relative abundance of species as a result of the test. These factors might influence the long-term recovery of the close-in area, or indirectly affect the survival of vertebrates in these areas.

The area selected for the test was 4317 feet above sea level and located at the north end of Yucca Flat. This desert basin is about 15 miles long and 10 miles wide, in the northern portion of the Nevada Test Site. Floristically it is part of the broad transition between the Mojave Desert and Great Basin (Beatley 1962). The area in the vicinity of ground zero had been used for testing in the past and much of the native vegetation had been destroyed and replaced by Russian thistle (*Salsola kali*) and stick-leaf (*Mentzelia veatchiana*). However, to the northeast of ground zero—at least beyond 3000 feet —the vegetation in 1962 was relatively undisturbed (Fig. 2) and composed predominantly of shrubs, *e.g.*, hopsage (*Grayia spinosa*) and blackbrush (*Coleogyne ramosissima*). Studies of arthropods were centered in this area.

Methods and Results

Two study plots were established along a line running from ground zero to 10,000 feet on a grid azimuth of 58°. Between 3530 and 3800 feet, a 10 x 10 grid of 100 buried can traps was established

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Fig. 1. View of Sedan crater on Yucca Flat at the Nevada Test Site. Truck and monitors may be seen in left foreground.

on June 21 (Fig. 3). The traps were 30 feet apart and the grid was centered on the surveyed line. A similar grid was set up between 8730 and 9000 feet on June 23. The area of such grids was about 72,900 square feet (1.7 acres) in extent. The cans were 6.9 inches deep and 6.3 inches in diameter. All traps were covered with a square foot of masonite with one-inch legs at each corner. Except for June 27, when a small device was exploded on Yucca Flat, the traps in both grids were examined daily between June 22 and July 5. Live arthropods were removed from the traps, recorded, and released beneath the nearest bush so as to prevent unnatural losses due to predation. Dead animals were recorded and discarded. Traps were sealed on the afternoon of July 5, and remained closed until radiation intensities in the study area had declined to a safe level. Sampling was resumed on July 30, 24 days after the test, and continued for two weeks during August.

In June 1963 a new grid of 100 can traps was established between 4730 and 5000 feet from ground zero on the line described above. This new grid of traps, along with the two grids at 3800 and 9000 feet, was sampled daily between June 10 and June 28.

The arthropods recorded were common species (or species groups) which could be distinguished in the field. If errors in identification occurred they were probably in attempting to discriminate between species of young scorpions and between *Eleodes hispilabris* and other beetles of this genus.

The results of the sampling are given in Table 1.

Discussion

The interpretation of the numbers in Table 1 is uncertain for the following reasons. Small differences in the numbers of individuals captured do not necessarily imply real differences in abundance. Thus, when small numbers are involved, even relatively "large" differences are probably insignificant. Without repeated trapping in the same area, preferably by means of replicated grids in identical habitats, there is no way to assess the significance of such data except intuitively. The problem is first to identify any real differences suggested by the data, and then to determine whether these are related to the Sedan test.

The tenebrionid beetle, *Pelecyphorus pantex*, can be eliminated from further consideration. Its absence from traps during June, and its presence during August, is a seasonal activity effect unrelated to the Sedan test (see Allred *et al.* 1963). Secondly, the area at 9000 feet was not comparable to that at 3800 feet. Not only did the vegetation differ (see Jorgensen *et al.* 1963), but also the substratum at 9000 feet was desert pavement, while at 3800 feet it was sandy. The number of arthropods captured at 9000 feet was invariably less than that taken at 3800 feet.

The data based on samples taken at 9000 feet do not suggest any changes associated with the test. In fact, probably the only significant

Fig. 2. Northern portion of Yucca Flat looking northeast on June 21, 1962. Marker is 5000 feet from drilling site.

Table 1. Captures of arthropods in grids of 100 traps before and after the Sedan test of July 6, 1962.

	3800 feet			5000 feet		9000 feet	
Species	June 1962 (14)[1]	August 1962 (14)	June 1963 (18)	June 1963 (18)	June 1962 (12)	August 1962 (12)	June 1963 (18)
Scorpions							
Vejovis confusus Stahnke	28	106	40	60	19	22	10
Hadrurus hirsutus Wood	11	43	2	14	5	14	14
Orthopterans							
Arenivaga apacha (Saussure)	2	16	0	8	2	4	1
Stenopelmatus fuscus Thomas	76	19	97	225	3	0	0
Ceuthophilus spp.	16	6	2	4	5	6	0
Tenebrionid beetles							
Trogloderus costatus LeConte	20	91	122	144	6	1	5
Eleodes hispilabris (Say)	11	31	6	5	8	8	3
Pelecyphorus pantex Casey	0	532	0	0	0	6	0
Eleodes spp. (mostly *E. armata* LeConte)	40	20	0	2	18	9	0

[1]Number of days traps were examined.

difference between June of 1962 and 1963 was the failure to capture beetles of the genus *Eleodes* (except *E. hispilabris*) in 1963. The numbers of these beetles apparently declined at 3800 feet also but I do not believe the Sedan test was responsible. Other investigations have indicated that, except for the deposition of radioactive dust, there were no demonstrable effects of the Sedan test at 9000 feet (Martin 1963, Jorgensen *et al.* 1963, Turner and Gist 1965).

The remaining comparisons involve samples taken at 3800 feet at different times, and samples taken at 3800 and 5000 feet in June 1963. The 1962 samples at 3800 feet showed considerable differences in the numbers of arthropods captured. I believe it reasonable to assert that changes in numbers of certain species, or changes in susceptibility to capture, occurred between June and August. The increase in scorpions was due to the appearance of young animals in the traps, and is what would have been expected on the basis of earlier work by Allred *et al.* (1963). *Arenivaga apacha*, *Trogloderus costatus*, and *E. hispilabris* were captured in what were probably significantly larger numbers, but the causes for this increase are not known. On the other hand, the number of *Stenopelmatus fuscus*

Fig. 3. Yucca Flat looking northeast on June 21, 1962. Marker is 3500 feet from drilling site.

captured decreased sharply, and there may have been a significant drop in the number of camel crickets (*Ceuthophilus* spp.) captured. However, I discern no patterns in these events implicating the Sedan test.

In June of 1963 there were also indications of change at 3800 feet. The sampling time was about 30% longer in 1963 (18 days *vs.* 14 days), so some increase might be expected for this reason alone (*e.g.*, *Stenopelmatus*, *Vejovis*). However, the much greater abundance of *Trogloderus* cannot be explained on this basis. Furthermore, the samples contained fewer *Hadrurus*, *Ceuthophilus* and *Eleodes hispilabris*, and no other *Eleodes*. The apparent decline in numbers of *Eleodes* (other than *E. hispilabris*) has already been discussed. It is surprising that some arthropods (*e.g.*, *Stenopelmatus*, *Trogloderus*, and *Vejovis*) persisted so successfully in an area subjected to such devastation (Fig. 4). One might conjecture that herbivorous species would be extremely sensitive to the sort of disruption experienced at 3800 feet. On the other hand, carnivorous and omnivorous species would, at least for a time, have some available food. The apparent decline of the large carnivorous *Hadrurus hirsutus* may in some way be related to the extensive destruction of surface cover. Both *Stenopelmatus fuscus* and *Vejovis confusus* are carnivorous. *Trogloderus costatus* is probably omnivorous. The plant feeders (*Arenivaga apacha* and *Ceuthophilus* spp.) at least showed no signs of increasing at 3800 feet.

During June of 1963, more arthropods were captured at 5000 feet than at 3800 feet. Prior to the Sedan test these two areas were similar in terms of soils and vegetation but I have no pre-test arthropod data from 5000 feet. However, I believe that the greater numbers of arthropods taken at 5000 feet during June 1963 reflect better survival in this area. This is not surprising in view of the relative destruction at 3800 feet (Fig. 4) and at 5000 feet (Fig. 5). In short, except for the reduction in numbers of arthropods at 3800 feet compared to 5000 feet, I perceive no short-term test-related effects in the data in Table 1.

There is no clear-cut relationship between apparent changes in numbers and food habits, although there is a possibility that carnivorous or omnivorous forms persist more successfully than herbivorous ones in the areas where the above-ground vegetation is largely destroyed. If there were close-in effects, it is possible that they could have occurred because of destruction or modification of habitat, and not because of ionizing radiation.

Probably the most significant lesson which emerges from the above experience is that deducing real changes in arthropod populations on the basis of captures in traps is difficult, and requires a considerable sampling effort in order to avoid ascribing significance to differences which have occurred simply due to chance. There is also the difficulty of *seasonal variation* touched on indirectly in this paper, and treated in detail for the Nevada Test Site by Allred *et al.*

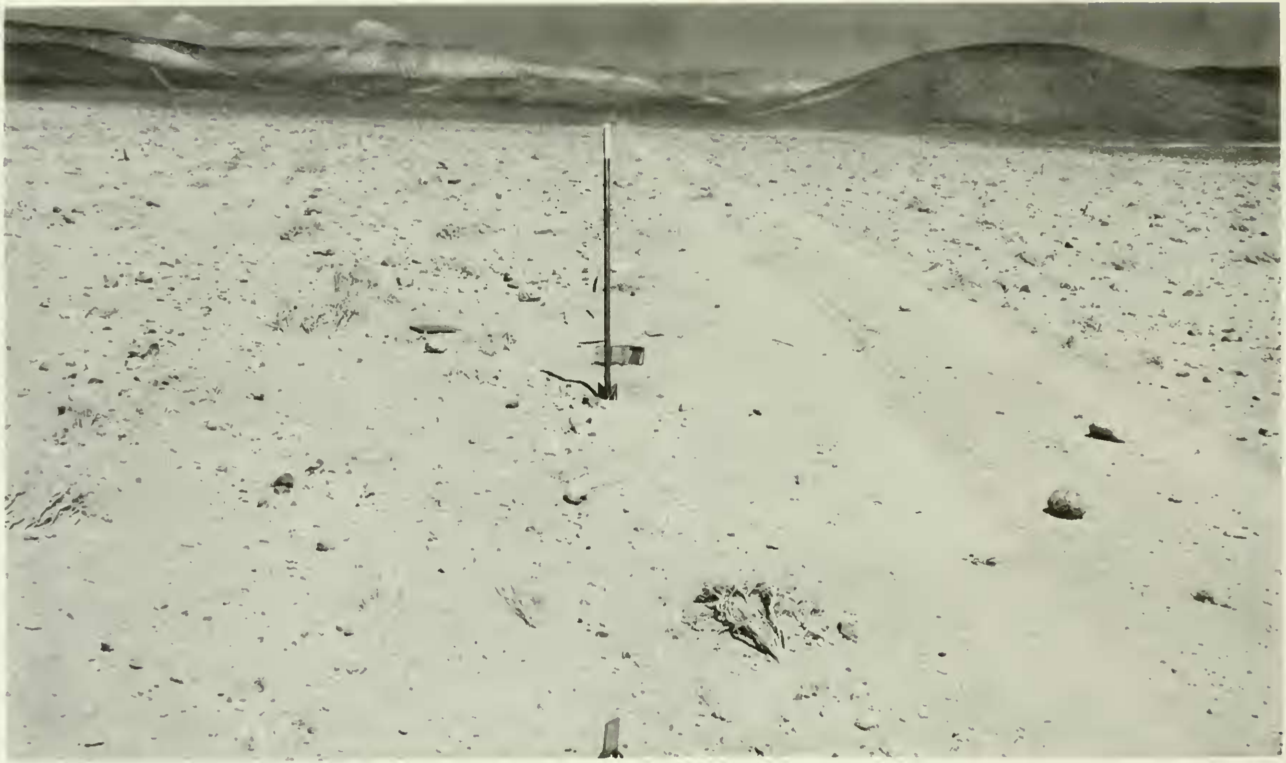

Fig. 4. Yucca Flat looking northeast on August 23, 1962. Marker is 3500 feet from ground zero. Compare with Fig. 3.

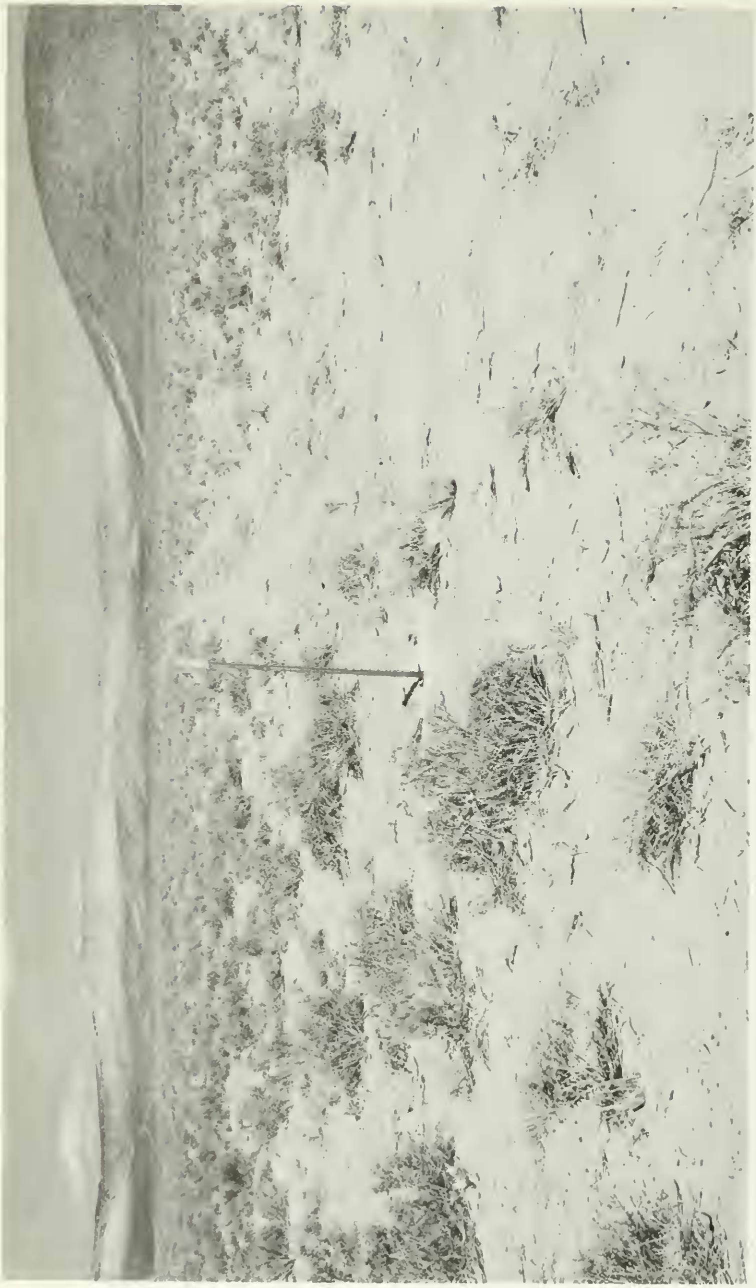

Fig. 5. Yucca Flat looking northeast on August 23, 1962. Marker is 5000 feet from ground zero. Compare with Fig. 2.

(1963). Examining the records of several consecutive years does not always guarantee the ability to evaluate the observations in some future year, because no two years are precisely equivalent. Finally, even if statistics and/or intuition suggest that the sampling reflects true changes in numbers, the causes for such changes are apt to be extremely elusive. With so many factors governing the numbers of arthropods captured, it is almost impossible to pinpoint effects due to some specific cause, unless there are across-the-board changes obviously attributable to this particular influence.

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